

CLAIMS

What is claimed is:

1. In an optical network comprising an optical splitter connected to (1) a working optical subscriber unit (OSU) of a working circuit via a working optical fiber, (2) a protection OSU of a protection circuit via a protection optical fiber, and (3) one or more optical network terminals (ONTs), a method for enabling fast protection switching from the working OSU to the protection OSU, comprising the steps of:
 - 5 (a) synchronizing the working and protection OSUs;
 - 6 (b) processing one or more upstream ranging reply PLOAM cells received at the protection OSU during ranging operations of the working OSU;
 - 8 (c) measuring arrival times of corresponding upstream ranging reply PLOAM cells at both the working and protection OSUs; and
 - 10 (d) generating a propagation delay value based on the arrival times for use by the protection OSU for communications with the one or more ONTs if and when protection switching is implemented upon detection of a failure in the working circuit without requiring the protection OSU to perform any ranging for the one or more ONTs.
1. The invention of claim 1, wherein the optical splitter is a passive optical splitter and the optical network conforms to ITU-T Recommendation G.983.1.
1. The invention of claim 1, wherein the optical network further comprises:
 - 2 one or more additional working OSUs, each connected via an additional working optical fiber to an additional optical splitter, which is further connected to one or more additional ONTs; and
 - 4 an optical switch connected to each of the optical splitters via a protection optical fiber and to the protection OSU, wherein the optical switch is controlled to sequentially connect the protection OSU to each of the optical splitters to implement steps (a) through (d) to generate a different propagation delay value for each working OSU for use by the protection OSU in communicating with the one or more ONTs corresponding to a particular working OSU if and when protection switching is implemented upon detection of a failure in the working circuit corresponding to the particular working OSU without requiring the protection OSU to perform any ranging for the one or more ONTs.
1. The invention of claim 1, wherein the propagation delay value is generated taking into account differences in upstream and downstream transmission speeds that result from different upstream and downstream transmission wavelengths.

1 5. The invention of claim 1, wherein step (a) comprises the step of synchronizing frame counters at
2 both the working and protection OSUs.

1 6. A machine-readable medium, having encoded thereon program code, wherein, when the program
2 code is executed by a machine, the machine implements, in an optical network comprising an optical
3 splitter connected to (1) a working optical subscriber unit (OSU) of a working circuit via a working
4 optical fiber, (2) a protection OSU of a protection circuit via a protection optical fiber, and (3) one or
5 more optical network terminals (ONTs), a method for enabling fast protection switching from the
6 working OSU to the protection OSU, comprising the steps of:

7 (a) synchronizing the working and protection OSUs;

8 (b) processing one or more upstream ranging reply PLOAM cells received at the protection OSU
9 during ranging operations of the working OSU;

10 (c) measuring arrival times of corresponding upstream ranging reply PLOAM cells at both the
11 working and protection OSUs; and

12 (d) generating a propagation delay value based on the arrival times for use by the protection OSU for
13 communications with the one or more ONTs if and when protection switching is implemented upon
14 detection of a failure in the working circuit without requiring the protection OSU to perform any ranging
15 for the one or more ONTs.

1 7. In an optical network comprising an optical splitter connected to (1) a working optical subscriber
2 unit (OSU) of a working circuit via a working optical fiber, (2) a protection OSU of a protection circuit
3 via a protection optical fiber, and (3) one or more optical network terminals (ONTs), a method for
4 enabling fast protection switching from the working OSU to the protection OSU, comprising the steps of:

5 (a) synchronizing the working and protection OSUs;

6 (b) initiating a cell delineation procedure at the protection OSU during normal, non-ranging
7 operations of the working OSU to enable the protection OSU to correctly delineate upstream cells;

8 (c) measuring arrival times of corresponding upstream cells at both the working and protection
9 OSUs; and

10 (d) generating a propagation delay value based on the arrival times for use by the protection OSU for
11 communications with the one or more ONTs if and when protection switching is implemented upon
12 detection of a failure in the working circuit.

1 8. The invention of claim 7, wherein the optical splitter is a passive optical splitter and the optical
2 network conforms to ITU-T Recommendation G.983.1.

1 9. The invention of claim 7, wherein the optical network further comprises:
2 one or more additional working OSUs, each connected via an additional working optical fiber to an
3 additional optical splitter, which is further connected to one or more additional ONTs; and
4 an optical switch connected to each of the optical splitters via a protection optical fiber and to the
5 protection OSU, wherein the optical switch is controlled to sequentially connect the protection OSU to
6 each of the optical splitters to implement steps (a) through (d) to generate a different propagation delay
7 value for each working OSU for use by the protection OSU in ranging the one or more ONTs
8 corresponding to a particular working OSU if and when protection switching is implemented upon
9 detection of a failure in the working circuit corresponding to the particular working OSU.

1 10. The invention of claim 7, wherein the corresponding upstream cells are upstream PLOAM cells
2 that are not associated with ranging by the working OSU.

1 11. The invention of claim 7, wherein the propagation delay value is generated taking into account
2 differences in upstream and downstream transmission speeds that result from different upstream and
3 downstream transmission wavelengths.

1 12. The invention of claim 7, wherein the protection OSU is configured into the optical network after
2 the working OSU has completed ranging for the one or more ONTs.

1 13. The invention of claim 7, wherein the cell delineation procedure is implemented using a state
2 machine comprising:

- 3 (A) a hunt state wherein different timing positions are used for different BMR reset pulses;
- 4 (B) a presync state wherein a single timing position is used for different BMR reset pulses; and
- 5 (C) a sync state wherein a single timing position is used for different BMR reset pulses, wherein:
 - 6 (i) a state transition from the hunt state to the presync state occurs as soon as a first specified
7 number of valid sets of data are identified;
 - 8 (ii) a state transition from the presync state to the hunt state occurs as soon as a second specified
9 number of invalid sets of data are identified;
 - 10 (iii) a state transition from the presync state to the sync state occurs after a third specified number
11 of consecutive valid sets of data are identified; and
 - 12 (iv) a state transition from the sync state to the hunt state occurs after a fourth specified number
13 of consecutive invalid sets of data are identified.

1 14. The invention of claim 13, wherein the first and second specified numbers are both 1.

1 15. The invention of claim 7, wherein ranging is not required to be performed by the protection OSU
2 after the protection switching in order to support the communications with the one or more ONTs.

1 16. The invention of claim 7, wherein step (a) comprises the step of synchronizing frame counters at
2 both the working and protection OSUs.

1 17. A machine-readable medium, having encoded thereon program code, wherein, when the program
2 code is executed by a machine, the machine implements, in an optical network comprising an optical
3 splitter connected to (1) a working optical subscriber unit (OSU) of a working circuit via a working
4 optical fiber, (2) a protection OSU of a protection circuit via a protection optical fiber, and (3) one or
5 more optical network terminals (ONTs), a method for enabling fast protection switching from the
6 working OSU to the protection OSU, comprising the steps of:

7 (a) synchronizing the working and protection OSUs;

8 (b) initiating a cell delineation procedure at the protection OSU during normal, non-ranging
9 operations of the working OSU to enable the protection OSU to correctly delineate upstream cells;

10 (c) measuring arrival times of corresponding upstream cells at both the working and protection
11 OSUs; and

12 (d) generating a propagation delay value based on the arrival times for use by the protection OSU for
13 communications with the one or more ONTs if and when protection switching is implemented upon
14 ~~detection of a failure in the working circuit.~~